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ABSTRACT

A project at Loyola University introduced microcomputers into the animal operant laboratory taught in conjunction with a course on the psychology of learning. An IBM-compatible (Zenith) microcomputer, interfacing components, and the OPERANT/PC software program were selected to control the operant chambers and collect data. An instructor-generated survey was conducted to assess students' prior experience and computer skills, and handouts, demonstrations, and an initial computer assignment were developed to introduce the system. At the end of the course, students completed the instructor-generated survey again. Evaluation of the system was based on student reactions, student performance, and survey responses. Results indicated that the system allowed laboratory activities to be expanded and to include more information, freed the instructor from technical duties so that he could focus on course content, and provided students with better laboratory and research experience as well as an introduction to computers. Six references are listed. (MES)

Issues in Integrating Computers into an Operant Lab Course

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Running Head: INTEGRATING COMPUTERS INTO AN OPERANT LAB

Author Notes

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Abstract

Several issues were encountered in integrating a microcomputer system into an existing operant lab. These include: hardware and software needs, their level of difficulty, their compatibility with existing equipment, and the skill level of the users. An evaluation of the hardware and OPERANT/PC (LSA) software used is also presented. Expanded and improved lab activities and increased coverage of course principles have resulted from this computer integration. The evaluation of the effects on the course and the revisions in course materials and activities as a result of computer implementation are discussed.

Issues in Integrating Computers into an Operant Lab Course

The use of microcomputers for instructional purposes in Psychology departments has come to include simulations, demonstrations, and replications of classic experiments on one level and experiment generation, data collection, reduction and analysis on a more advanced level (Butler, 1988; Castellan, 1983; Eamon & Butler, 1985). In some laboratory situations, computers are used to operate and control older electro-mechanical equipment, but this typically requires hardware interfacing.

Castellan (1986) and Eamon (1986) have addressed several factors that need to be considered in introducing computer-based instruction. Among these factors are: considerations of the hardware and software needed, an evaluation of their suitability and their level of difficulty; the level of computer expertise of the instructor and the skill level of the students; modification of the course materials; and an evaluation of the effectiveness of the computer component. The limits and flexibility of the software and of the individuals involved are paramount in instituting computerized laboratories. However, many computer laboratories typically consist only of computers and software. Pre-existing laboratories contain necessary equipment that few departments could

afford to replace entirely with state-of-the-art components. Consequently, an additional factor arises in integrating a computer component into an existing laboratory: the compatibility of computer hardware and software with existing equipment.

The purpose of the present paper is to discuss how these factors were addressed in computerizing an existing operant laboratory. In addition, a description and evaluation of the system utilized in the laboratory is provided.

Course and Project Overview

In Fall, 1987, a project was begun in the Psychology department of Loyola University, New Orleans, to introduce microcomputers into the Psychology curriculum, under a grant from the National Science Foundation, College Science Instrumentation Program (NSF/CSIP). Among the primary goals of this project was to upgrade the pre-existing laboratory conditions in the operant lab.

The Animal Operant Lab is taught in conjunction with the Psychology of Learning and provides students with structured laboratory experiences in the operant conditioning of a laboratory rat. Students are required to run daily operant sessions for six weeks, during which they expose their subject to various schedules of reinforcement and discrimination training.

Students collect data, perform some minimal analyses, and produce an APA-style report based on these experiences.

The upgrade of this laboratory involved the introduction of an IBM-compatible microcomputer, interfacing components, and appropriate software to control the operant chambers.

Equipment Considerations

Hardware. Pre-existing conditions in this lab consisted of three operant chambers (2 Gerbrands model G6312 and 1 Grason-Stadler model E3125B-100, each approximately 12 years old) controlled by rather dated electro-mechanical components. Laboratory assignments and data collection with this equipment were limited to only the most basic measurements (number of responses and reinforcements) under simple schedules of reinforcement (continuous, extinction, fixed ratio).

The computer component for this lab included a Zenith microcomputer (model Z-159), equipped with a 20 mg. hard disk and monochrome monitor. The software selected to control the operant chambers was OPERANT/PC: Conventional and Microanalysis of Operant Behavior, developed by Stephen C. Fowler (1986) and distributed by Life Science Associates (LSA). This software package was billed by LSA as allowing the independent and simultaneous operation of up to 8

operant chambers, with minimal hardware requirements (IBM PC compatible computer with 128k RAM minimum, LSA interfacing hardware). Interfacing components consisted of a John Bell Universal PC I/O board with modifications (LSA), a convenience board (LSA), and a mating connector cable for the two boards (LSA). A transistor driver board (LSA) was also employed to operate the various DC devices of the operant chambers.

Documentation provided with the LSA software allowed for easy installation of the John Bell I/O board into the computer and subsequent connection to the convenience board. The connection of the convenience board terminals to the chambers and devices was not as simple or as well-defined in the manual. Documentation concerning this stage of installation seemed too brief and lacking in the detailed descriptions needed by inexperienced users. A higher degree of expertise than was possessed by the laboratory instructor seemed to be assumed in the manual. The connection involved an input or output and a ground for each device (start, responses, reinforcement, discriminative stimulus). However, once one connection had been properly established, the same logic applied to the other switches and devices. The convenience and transistor driver boards are not encased in any sort of protective enclosure. While a warning is listed on the boards, and additional

warnings can be posted in the area, exposed live terminals would hardly be desirable in any lab situation. Inexpensive containers can be assembled or purchased from an electronics store to minimize this problem, ! ever. The hardware seems to be compatible with various types of operant chambers. No compatibility problems were encountered with either type of operant chamber in the lab, Gerbrands or Grason-Stadler. No special connectors or configurations were necessary. Once all connections were established no further adjustments, modifications, or repairs were needed during the first semester the system was employed. The simplicity and flexibility of the hardware more than compensated for the minor difficulties created by the connection instructions and/or lack of expertise on part of the user.

Software. While the degree of control of the chambers and data collection are of paramount importance in the laboratory, the ease of operation of the equipment becomes a primary concern in a student lab course. The OPERANT/PC software package seems extremely well suited to those who have minimal computer and/or programming skills. In the present application, the software was interactive enough to allow students with no prior computer experience to run the software unsupervised after only one 50-min. class session of instruction.

The software documentation and instructions are excellent, being explicit, clear, and comprehensive. The software is query-driven and allows experimental parameters to be saved as parameter files on disk to ensure that conditions remain consistent across subjects and days. In addition to 5 simple schedules of reinforcement (FR, VR, FI, VI, DRL), multiple schedules can be constructed. A discriminative stimulus (SD) for use with multiple schedules is not overly elaborate, capable only of signaling only a single change in schedule.

In the Animal Operant Lab course, students are required to run daily operant sessions for 5 1/2 weeks during which they are exposed to CRF, extinction, VR9, extinction, FI45", extinction, and discrimination training on a 90-sec. alternation of FR10-EXT schedules. Students were unsupervised during these sessions and no problems were encountered in the first semester of the computer implementation. Session summary printouts were generated by the program and provided the students with summarized data in a concise and well-labeled manner. Individual subject daily data files were written to a separate directory on the hard disk, which proved to be the most complicated computer activity students had to master. These data files could be printed out via RAWDATA program of the package, or reduced to statistical data summaries via

MEANS program. While MEANS provided all relevant information for student lab reports, these data files could potentially be used with other more advanced statistical packages with minimal editing.

Two shortcomings of the software package were noted. These involve (1) the correction of mistakes, which are very common among inexperienced users, and (2) the timing control of multiple chamber sessions.

Once the program has begun, there is apparently no simple way to exit or cancel it, or at least no documented method. The only solution found was re-booting. Correcting errors in user responses is also apparently not possible after the return key has been used (or is undocumented) without re-booting and re-starting the program. Although the screen prompts and queries state that the "root" portion of the data file names can be corrected, other parameter file information could not be altered.

The package allows for up to 4 chambers to be controlled and for chamber sessions to be of different schedules and durations. However, it appears that the timing session of all chambers begins when the start switch for Chamber 1 on the convenience board is depressed. That is, Chamber 1 and Chamber 2 seemingly must be started at the same time, otherwise the session duration of Chamber 2 will not be of the desired length. Another limitation found was that Chamber 1

must be active (started) in order for any other chamber to be started. These timing limitations were handled with student scheduling manipulations and constraints.

The OPERANT/PC package distributed by LSA appears to be a simple, flexible, inexpensive, basic system for the control of operant chambers. This package has the desired features for use in a student laboratory: ease of operation, clarity of documentation, relevant data collection and reduction, clearly labeled printouts, and construction and retention of experimental parameter files for controlling lab activity sessions. In addition, the printouts generated by the OPERANT/PC software could be used to identify students having various types of problems with the computer, such as changing directories, employing the wrong parameter file, or using an incorrect data file name. While two minor operation limitations were detected, the offerings outweigh any inconvenience these may cause.

User Expertise

Eamon (1986) notes that most course instructors could not or would not claim to be computer experts and that students often run the gamut in skill sophistication. In the present case, the laboratory instructor, while possessing some computer skills, could best be described as minimally knowledgeable about software and inexperienced with hardware. While

this was a factor in hardware/software selection, the interfacing and set-up procedure in the lab resulted in an increase in skill level in these areas. As Eamon (1986) notes, using computers in a laboratory will require instructor familiarity with the hardware and software. Running the program, making errors, and seeking assistance and explanations from others will often result in adequate instructor expertise.

Courses and instructors vary in the degree of supervision of laboratory activities. As a result, the amount of initial training, demonstrations, and written instructions also differ. In designing appropriate instructional protocols, demonstrations, and handouts to familiarize students with the computer component of a laboratory, an initial assessment of their knowledge and skill level should prove useful. An instructor-generated survey was used to determine the prior experiences and computer skills of students enrolled in the Animal Operant Lab course. Students were to indicate whether they could perform various computer tasks or possessed certain skills, such as can you "boot" a computer and do you know any programming languages. Questions to assess attitudes about computers and their use in educational and laboratory settings were also included in this survey. This survey was administered prior to the beginning of the lab and again six weeks later upon completion of the

lab course, although it was not expected that this laboratory experience with computers would produce any appreciable gain in skill level among the students.

The students enrolled in this course during the 1989 fall semester had only very low-level experience with computers and could be considered inexperienced. Approximately half of the students (N = 14) reported their current computer level as low, being unable to "boot" any computer system. The remaining students reported having some minimal expertise, either familiar with a word processing program and/or a few operating system commands (COPY, DEL, DIR). No student reported having the ability to set up directories, write, alter, or edit programs in any language, learn a new program without personal assistance, use advanced DOS commands, or having familiarity with a program other than a word processing program. In addition, the students did not have any hardware and/or interfacing experiences. While the major purpose of this assessment was to determine the skill level of students in the lab course, it could also be helpful in identifying potential student lab assistants for the course in future semesters and for other courses having a computer component.

The assessment did result in the development of two detailed computer handouts, an in-class demonstration, and an initial computer assignment.

While the original lab syllabus provided the student with information regarding lab animals, lab activities, and requirements, two additional lab handouts were added to the course materials with the introduction of the computer component and contained information specific to this aspect of the lab. The general computer handout presented an overview of the microcomputers in the Psychology department and provided some basic information about hardware, types of software, and designated uses for the machines. In addition, this handout provided very detailed instructions on "booting" the computer and the DOS commands FORMAT and COPY. The second handout contained information specific to the computer component of the Animal Operant Lab. It provided explicit instructions on how to turn on all necessary equipment, how to locate and start the OPERANT/PC program, and a step-by-step procedure for answering the computer queries in the operant program. The names of all operant session parameter files were provided along with a brief explanation of the schedule of reinforcement each would produce. In addition, the description and procedure for the "MEANS" program was also given as well as suggestions for utilizing the results it generated. Thus, these written materials supplied the student with a reference and a guide for interacting with the computer independently and included basic information,

detailed instructions, and procedures for correcting errors.

In class-demonstrations of the system and software will often trigger questions from both experienced and inexperienced users concerning the necessary inputs, responses, and their orders. Even the most experienced student would hardly be familiar with operant control software and its prompts and terminology. Therefore, an "introduction" day in which the instructor walked through the computer procedures was used to aid student understanding and to provided some minimal reduction in anxiety. During this 50 min. period, the instructor reviewed the computer procedure and students were encouraged to try the program themselves.

As suggested by Eamon (1986), students were given an initial computer assignment. This assignment required students to "boot" the computer, change directories, load and run the OPERANT/PC program with a special parameter file, and turn-in the session summary printout generated at the end of the OPERANT/PC program. It was anticipated that this assignment would identify students needing additional instruction, assistance, and/or encouragement in working with the computer. However, during this first semester of the computerized operant lab, all students successfully completed the initial computer task.

Evaluation

The evaluation of the microcomputer in the lab course was based in part on student reactions. In addition, an assessment of whether the computer was effective in reaching the goals and expectations of the instructor was made in light of student performance (Castellan, 1986).

At the end of the lab course, students were asked to complete the instructor-generated survey previously discussed. Five statements contained in the survey referred specifically to student reactions to computer use in the operant laboratory. Students responded to these statements on a 5-point scale, ranging from (1) strongly agree to (5) strongly disagree. The students in the Animal Operant Lab course gave favorable evaluations of the computerized lab ($X = 1.2$), use of computers ($X = 1.3$), and ease of using the software ($X = 1.2$). Students did not agree with statements regarding the lab as difficult because of the computer ($X = 4.6$) or that data collection and analysis using the computer were complicated ($X = 4.4$).

One of the basic goals the instructor had for the lab course was to provide the students with experiences that closely resembled experimentation and research rather than just an elaborate demonstration. As hoped, the introduction of the computer allowed student and faculty efforts to be focused on experimental design,

manipulation of variables, and the interpretation of data rather than the repair, rearrangement, and monitoring of equipment. In addition, the integration of the computer system allowed for increased coverage of operant principles, more detailed and accurate data collection, easier data reduction, and in-depth analysis of the data. The impact of the computer on the lab course was probably best revealed in the increased quality of student lab reports as compared with those of previous semesters. In general, the reports contained more information, included more data and analyses, and presented these in a clear and concise format. Overall, the system allowed lab activities to be expanded and to include more information and data, freed the instructor from technical duties to be able to focus on course content issues, and provided the students with better laboratory and research experiences, as well as a beginning introduction to computers.

Summary

The purpose of this paper was to discuss several issues in integrating a computer system into an existing operant lab. The system selected, OPERANT/PC (LSA), offered the flexibility and ease of use desired in a student lab. Both students and instructor possessed only minimal computer skills, yet only minor

problems were encountered. The system was rated very favorably and appears to be a useful laboratory tool. It is hoped that this information will encourage others to integrate computers into existing laboratories and thus expand the capabilities of these labs and courses and enhance the experiences of the students.

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